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MAPPING THE LITHOCERAMIC CLADDINGS CONSERVATION STATUS IN A BIM ENVIRONMENT

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Italian Modern Movement architecture is characterized above all by the research and use of innovative, experimental and autarkic materials. Lithoceramics is one of the most interesting and widespread cladding materials and represents the Italian reinterpretation of klinker, a very popular ceramic material in Germany and in the Netherlands. Despite the excellent technical performances of the ceramic cladding, increasingly frequent detachment episodes make maintenance interventions necessary on this building stock. Starting from a brief illustration of the characteristics of lithoceramics and of the most significant applications, the paper intends to present a BIM-based digitization methodology for mapping the conservation status of this façade cladding technology, through exemplification on a significant case study. The BIM model contains all the information necessary for the mapping of the state of conservation, for the recovery and maintenance activities of the ceramic elements. The proposed methodology allows a faster and more efficient visualization of the present faults and proposes a targeted intervention system, in relation to the detected fault. This approach contributes to protecting the historical connotation of this building heritage, favoring restoration and cleaning, reducing the time and, consequently, costs of maintenance.

Keywords: Built heritage, Building envelope, Klinker, Modern movement architecture, Italy.

1 INTRODUCTION

Italian Modern Movement architecture is characterized, on the one hand, by the original use of traditional materials, but above all by the research and use of innovative, experimental and autarkic materials (Cupelloni 2017). The lithoceramics is one of the most interesting cladding materials and represents the Italian reinterpretation of klinker, a very popular ceramic material in Germany and in the Netherlands (Minnucci 1933). It is a very compact ceramic product with a high percentage of glass phase, obtained by wire drawing and subjected to a firing cycle at a temperature of 1200-1280°C. The versatility of shape, colors, and finishing of the cladding elements makes the building external surfaces vibrating, colorful and iridescent. The use of this 'modern skin' covers a wide time period, from the '30s to the end of the '60s and is extremely widespread in Italy (Mangosio 2006).

The excellent technical performance of this cladding solution has generally ensured a very limited maintenance activity over time. In recent years, frequent detachment episodes of individual façade elements or entire portions of cladding have, however, necessitated maintenance or recovery interventions in many buildings. The detachment is generally due to the failure of the connection between the cladding and the layer support. This failure can be caused by the loss of the mechanical characteristics of the mortar or by excessive tangential stresses between the cladding and the wall support (absence of open joint between facing elements, the absence of structural expansion joint).

The lack of critical awareness about the architectural and technological value of this material has often led to interventions of complete replacement of the coating, causing the irretrievable loss of a singular heritage of technical culture.

The study intends to provide designers and operators with a tool to selectively guide the intervention and to keep technical information and operational prescriptions useful for subsequent maintenance activities.

2 METHODOLOGY

The progressive digitization of the historical heritage is implementing an information management process that involves the collection and management of data through the BIM model. All conservative maintenance interventions, therefore, need to have an information model, which meets the specific needs of operators and scholars working on buildings, in particular, those dealt with in this research, i.e. buildings with lithoceramic cladding. For a correct setting of the BIM model, the proposed methodology identifies the first phase of identification of the most common pathologies refererred to this type of cladding.

A first subdivision can be made in relation to the types of fault (De Freitas 2013), that is detachment or lifting of surface elements or sections, surface degradation, detachment of fragments (Figure 1). As regards surface degradation, there are five types of faults: a) efflorescence, or superficial deposit of salts present in the mixing water of the tiles or the laying mortar; b) proliferation of micro-organisms and moulds on the surface due to stagnant water; c) chemical and physical aggression of the environment on the surface treatment of the tile; d) urban pollution deposit in relation to particular conformations of the façade and to its orientation; e) cracking of the surface treatment due to internal cohesion states. Conservative maintenance interventions may include two main interventions: a) replacement of damaged elements and consolidation of the layer support, b) cleaning.

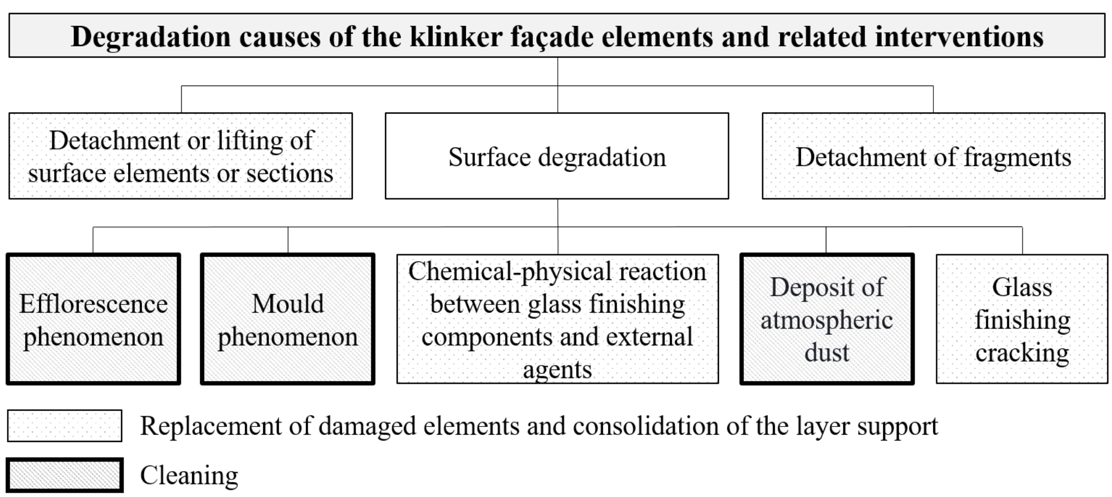

Figure 1. Degradation causes (Data processing by authors).

3 CASE STUDY

The case study is an apartment and office complex built in Turin between 1957 and 1959 for the real estate company ARVA by engineers Domenico Morelli and Felice Bardelli (Bagliani 1993). The ARVA House consists of two buildings separated by a courtyard-garden: the main building fronts onto Corso Marconi and is ten floors high, while the minor building on Via Sant'Anselmo - specific object of our study - is six floors high (Figure 2). The ground floor is intended for offices, while the upper floors have one flat per floor. A corner bow-window enlarges the living room space.

The secondary building is entirely covered in rectangular elements in ivory colored klinker (9.5 x 19.5 cm), supplied by Piccinelli Ceramics in Bergamo, which are arranged vertically and placed with open joint, so as the joint itself is able to absorb to any differential movement of the cladding due to the thermal expansion of the masonry support. The standard element has three posterior dovetail ridges for a better adherence to the bedding mortar.

In the original project the cladding equipment, the clamping device to the masonry and the resolution of every critical and singular technological crux are analyzed and illustrated up to the maximum detail scale. The care for the technological detail by the designers reveals the search for a lasting solution over time.

The critical points of the cladding, such as the edges, resolved continuously without an interposed joint, or the folds on the intrados of the cantilevered floor, defined with special angular elements, are approached with great care. The window outlines are obtained by subtraction from the modular structure of the cladding and the openings are defined with special pieces in L shape.

Figure 2. View of the ARVA House façades from the street (Ph. M. Mangosio).

4 RESULTS

Applying the proposed methodology to the case study presented in the previous paragraph, an in-depth research on the historical project documents was carried out, studying, in particular, the construction details and the technological solutions proposed by the designers (an extract is shown in Figure 3a).

In fact, the modularity of the material required a very accurate study of the singular points (angles, spouts, vaults, etc.) to then define the vertical trend of the more regular part of the façade (Figure 3b).

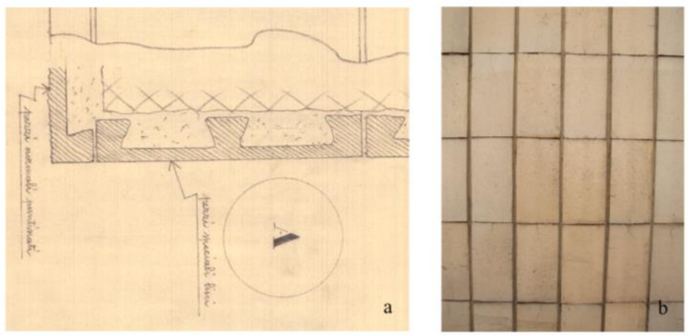

Figure 3. a) Details of the façade klinker element (Politecnico di Torino DIST, Laboratory of History and Cultural Heritage, MRL_23B17ARVA_83) – b) Detail of the regular part of façade (Ph. M. Mangosio).

Following the project indications, the family model of the "Klinker" façade element was created. In the geometric modeling phase, the dimensions were inserted as object parameters (Figure 4).

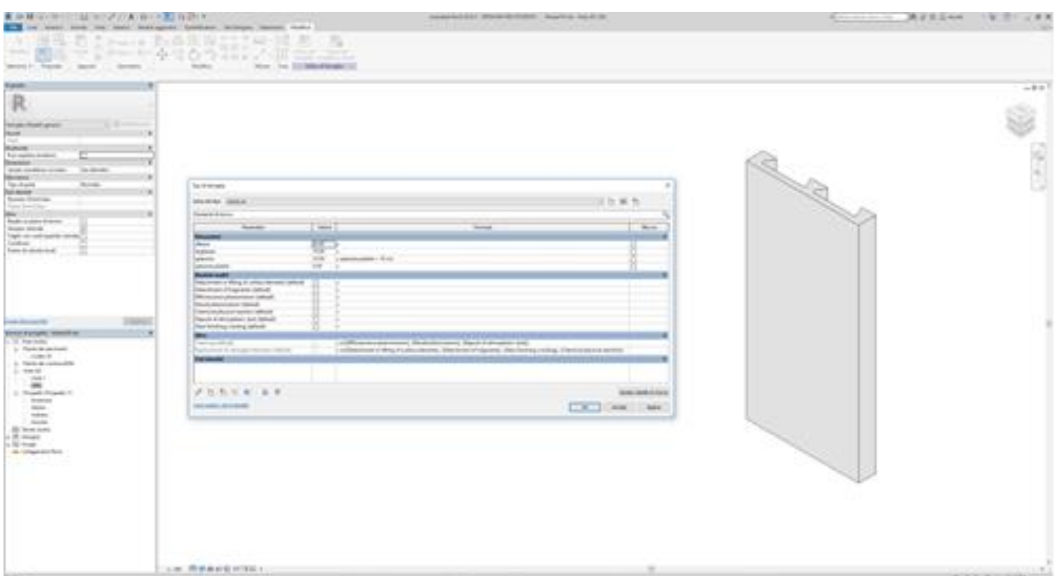

Figure 4. 3D view of the Klinker family model with parameters of the degradation state of the elements (Data processing by authors).

This operation makes the use of these elements more flexible even for projects that have a similar technology but with slightly different geometries. The BIM model was then associated with the information component, i.e. all the parameters that must be completed in order to correctly define the state of conservation.

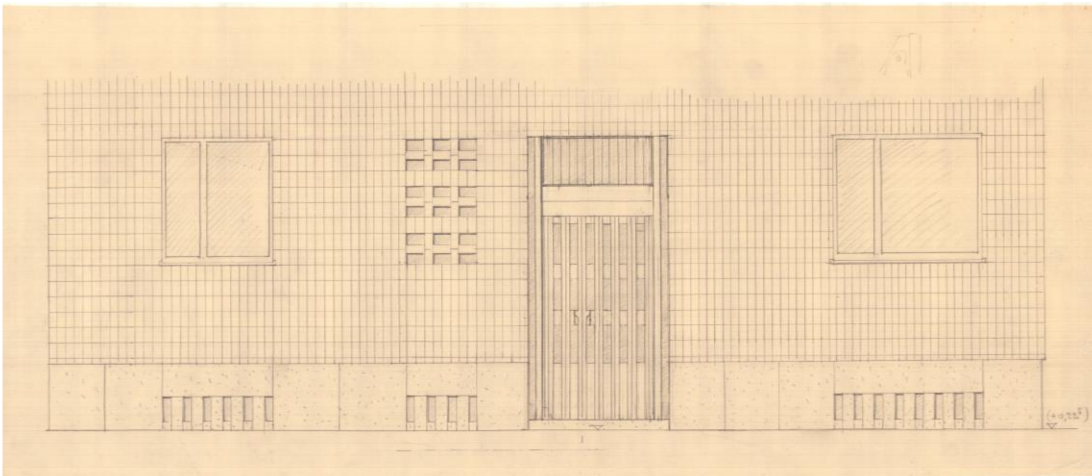

Figure 5. D. Morelli, F. Bardelli, Façade drawing of the secondary building, 1957-1959 (Politecnico di Torino DIST, Laboratory of History and Cultural Heritage, MRL_23B17).

By visualizing the façade's projections, referring to the original drawing (Figure 5) and associating a color to each fault, the areas on which work must be immediately identified and, in relation to the degradation causes, the intervention mode is automatically defined (Figure 6).

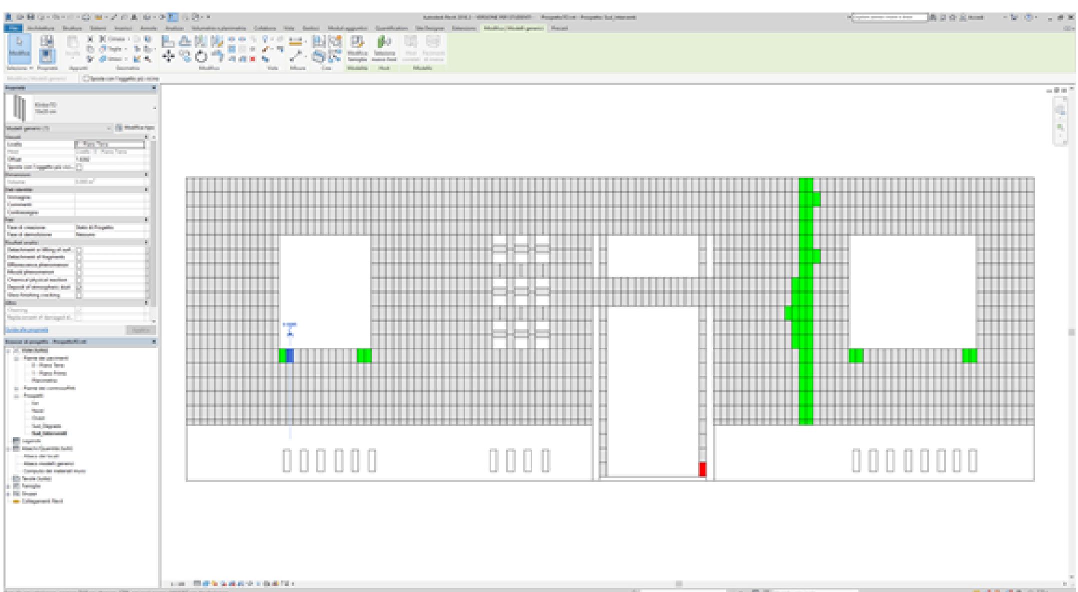

Figure 6. View of the elevation of the BIM model in which it is highlighted the state of maintenance of the façade cladding and the suggested intervention mode. In green, cleaning; in red, replacement of damaged elements and consolidation of the layer support (Data processing by authors).

5 CONCLUSIONS

In Italy, the litoceramic cladding not only connotes numerous architectures of the Modern Movement but also numerous buildings of lesser authors, of recognized design value, created between the Thirties and the Sixties in many Italian cities. This architectural heritage is not protected by Italian legislation but must be preserved as well as the great historical architecture.

The recent regulations which favor the improvement of energy performance, unfortunately, do not take into account the cultural, historical and technological value of these buildings, with the result that often the façades are covered with external wall insulation systems or, in the worst case, demolished and replaced with ventilated façades or with anonymous coatings.

The proposed methodology contributes to the digitalization of the historical heritage, assisting, with innovative technological tools, processes, and mapping of the degradation already in use. The BIM-based data collection allows storing a large amount of data, linking information on the state of conservation and degradation to each coded element, on how to restore/replace elements and on the cleaning products to be used.

This type of approach allows to keep information about the building history, the cladding building technique and the characteristics of the material, to intervene in a coherent and conscious way, especially in the case of the replacement of the elements, to evaluate and perform only the processings actually necessary, to contain maintenance costs and finally to keep memory of the intervention for the benefit of future maintenance.

In the next few years it will be necessary to intervene substantially on this heritage for reasons of obsolescence: to this end, as a next step of the research, the system here described could be linked to the databases currently used by companies for the routine maintenance of buildings.

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